Will the Benefits and Costs of Bovine Growth Hormone be Distributed Fairly?

by
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Bovine somatotropin (bST) or growth hormone (bGH) has received more *ex ante* socioeconomic analysis than any previous farming technology. However, some dimensions, particularly the distribution of costs and benefits of bGH, have not been analyzed. The purpose of this paper is to fill such gaps in knowledge.

This paper finds that net benefits from bGH would be distributed more equitably in relation to consumers' income than are all farm and food technologies or national income. Distribution of impacts among regions and farm sizes are also examined. Impacts would not differ much among regions, but large farms would benefit more than would small farms from bGH. Nonetheless, the impacts of the technology would be much more evenly spread among farms than are most technologies.

Impacts of bGH

This section analyzes the distribution of bGH costs and benefits among consumers, farmers, and regions. Distributional impacts cannot be separated from economic efficiency, food safety, and the environment. Hence these too are briefly addressed.

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Economic Efficiency

Bovine growth hormone is economically very efficient. Based on the most likely increase in average U.S. milk production per cow from bGH, Fallert *et al.* (p. 8) estimated a net return to farmers of $2 for each $1 of bGH cost. This net return would drop as milk prices would fall and benefits would go to consumers after adjustments.

The expected 15 percent increase in milk per cow and 8 percent net reduction in dairy product costs to U.S. consumers would, *after adjustments*, reduce dairy product consumption costs by $9 per family per year or nearly $1 billion to the nation based on 1985 conditions (see Table 1).[1] With this larger "pie" of GNP, in theory it is possible to compensate losers so no one is worse off.

At issue is whether an 8 percent decrease in farm cost per unit of milk will be passed to consumers. The traditional populist view is stated by Comstock (p. 331):

> History, again, is a good anecdote for such rhetoric [that farm costs reduced by bGH will be passed to consumers]. ... The facts are that intermediate markets seem to have a way of absorbing whatever profits are made when farmers' prices go down. There is little reason to think that bGH usage would lower milk prices for the urban poor, or any consumers.

Comstock's conclusion was based on anecdotal evidence from personal observations. The conclusion is contradicted by careful economic analysis which controls for wages, inflation, interest, and other marketing costs to determine net transfer of farm prices to the retail level.

Comprehensive empirical results from Kinnucan and Forker (p. 291) indicate that increases in farm dairy product prices are more quickly passed to consumers than decreases in farm prices. But, most importantly, Kinnucan and Forker (p. 291) concluded that "... the decreases in the farm price of milk are eventually passed along to consumers." The latter agrees with a more recent analysis of dairy price margins by Novakovic and with a comprehensive analyses of marketing margins for a wide range of agricultural products (Council of Wage and Price Stability).

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[1]The estimate assumes that the cost of 24 cents per treated cow per day covers all production and development outlays of bGH supplies. The addition to GNP could be larger if net returns to producers of bGH are included and are positive.

Another distortion is commodity programs which can keep a reduction in farm costs from being reflected in farm-gate milk prices. Using data for 1972 to 1986 from the latest USDA (August 1990) *Economic Indicators* series, Figure 1 shows that commodity programs have not shielded farm-gate receipts per cwt from changes in costs. Both real costs and receipts increased from 1972 to 1974; from 1980 to 1986 both real costs and receipts decreased.[2] The simple regression coefficient of receipts per hundredweight as a function of costs over the 1972-86 period was 1.011 and the adjusted R^2 was .81. The coefficient was not significantly different from 1.0, indicating that a $1 reduction in costs was associated with a $1 reduction in receipts. Commodity programs adjust to costs.[3] Evidence in Figure 1 supports the assumptions in Table 1 that production cost savings from bGH will be reflected in farm-gate prices after time for adjustment.[4]

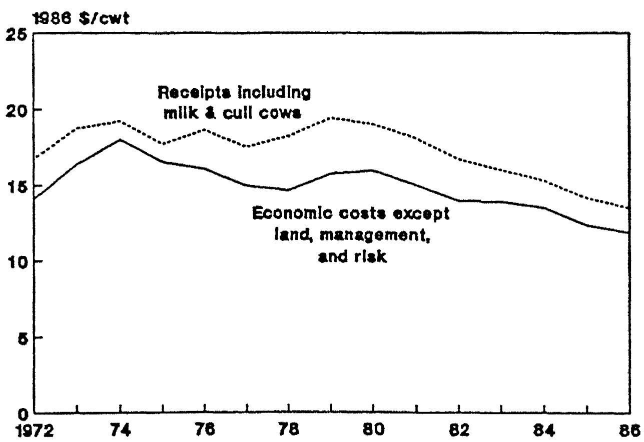

Figure 1. Real Economic Receipts and Costs -- The Dairy Industry.
Source: USDA (August 1990). Adjusted by GNP deflator, 1986 = 100.

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[2] The difference between cost and receipts in Figure 1 is the return to land, management, and risk. Management and risk costs were excluded because they were not available. The land cost was excluded to avoid attributing to cost the higher land prices caused by higher milk receipts. On the average for the 1972-86 period, all receipts exceeded costs other than for management and risk by 14 percent -- a favorable return indeed to management and risk A more typical management return for other farm enterprises is 5 percent of receipts. It also suggests government programs provided some economic rent.

[3] The 1990 farm bill sets a minimum price support of $10.10 per cwt of milk, hence would appear not to have the downward price flexibility of the 1985 farm bill. If a coreponsibility levy is imposed on producers to pay for surplus disposal costs, the impact could be similar to the 1985 farm bill.

[4] The estimates of gains from bGH used herein are considered to be the maximum after adjustments in marketing margins and farm programs. Benefits and required adjustment will be less if changes are less than assumed.

It should be noted that the $1 billion gain to consumers from bGH remains a gain to the nation even if it is retained in part or whole by producers or the marketing sector. If it goes to producers because of support price rigidity, the impact would be to raise the price of land, cows, and other "fixed" assets.

Equity: Distribution of Benefits of bGH Among Consumers

A given addition to income gives less satisfaction when received by the rich than by the poor, hence economic gains from bGH will be greater if its benefits are distributed toward low income than toward high income families. Table 1 assesses that issue (see Tweeten and Mlay for evidence of diminishing marginal utility of income). As noted earlier, the assumption based on estimates by Fallert *et al.* is that cost is reduced 8 percent per pound of milk produced if bGH is used to the point where it brings an overall 15 percent increase in milk production. (Hallberg and Fallert (p. 14) also estimated that the price of milk would drop 8 percent, but from a 10 percent rightward shift in the supply curve for bGH.)

Consumer expenditures survey results for 1985 obtained from the Bureau of Labor Statistics (BLS) permitted division of dairy product consumption into components for (1) fresh milk and cream and (2) other dairy products. In 1985, the farm share of consumer fluid milk expenditures was 49 percent; the figure for other dairy products was 36 percent (see Putnam; Dunham). These numbers were used to calculate the farm expenditure portion for dairy products by consumer income groups and the total of fluid milk and other dairy products was summed to obtain the total bGH contribution per household.

Under 1985 base year assumptions, full utilization of bGH technology passed to consumers would save the average consuming unit $5.14 on fresh milk consumption and $3.89 on other dairy product consumption, for a total of $9.03 (Table 1). As a proportion of income, savings are much greater for low income than for high income families. For families with incomes under $5,000 per year, savings from bGH would be .23 percent of income. This is 11 times the percentage of income, .02, saved through bGH by families with incomes of $40,000 or more per year. The ratio of percent of income saved for low income families compared to high income families is 11.0 for bGH, 8.5 for all food, and 1.0 for all goods and services including savings. Thus the distribution of benefits from bGH is much more equitable toward low income consumers than is the distribution of efficiency gains from all food production or all income generation. It would be difficult indeed to find alternative high-payoff investments giving as high a proportion of benefits to low income families. What appears

Table 1. Consumer Gain from bGH by Income Level, 1985.

	All Units	Family Annual Income, $1,000: Less than $5	$5 to $10	$10 to $15	$15 to $20	$20 to $30	$30 to $40	$40 and Over
Number of Consumer Units (1,000)	91,441[a]	7,011	12,505	9,618	6.603	13,359	9,752	12,577
Percent of Total	100.0	9.8	17.5	13.5	9.2	18.7	13.7	17.6
Annual Income before Taxes	$24,632	$2,086	$7,318	$12,272	$17,411	$24,331	$34,253	$60,519
Size of Consumer Unit (Persons)	2.6	1.7	2.1	2.4	2.4	2.7	3.0	3.2
Age of Reference Person (Years)	46.7	47.5	53.5	48.9	46.4	42.4	42.6	43.8
Ratio of Earners to Children under 18 (Number)	2.0	1.8	1.0	1.4	2.0	2.0	2.0	2.3
Average Annual Expenditures[b]								
Food								
Total Consumption	$3,115.84	$1,547.00	$1,986.92	$2,539.68	$2,727.40	$3,241.16	$3,848.52	$5,271.76
Percent of Income[c]	12.6	74.2	27.2	20.7	15.7	13.3	11.2	8.7
Fresh Milk and Cream								
Total Consumption	$131.04	$76.44	$108.16	$129.48	$124.80	$134.68	$164.32	$168.48
Farm Portion (Dollars)[d]	$64.21	$37.46	$53.00	$63.45	$61.15	$65.99	$80.52	$82.56
bGH Contribution (8% of Farm Portion, Dollars)	$5.14	$3.00	$4.24	$5.08	$4.89	$5.28	$6.44	$6.60
Percent of Income[c]	0.021	0.144	0.058	0.041	0.028	0.022	0.019	0.011
Other Dairy Products								
Total Consumption	$135.20	$65.52	$88.92	$109.72	$117.00	$143.52	$177.84	$230.36
Farm Portion (Dollars)[e]	$48.67	$23.59	$32.01	$39.50	$42.12	$51.67	$64.02	$82.93
bGH Contribution (8% of Farm Portion, Dollars)	$3.89	$1.89	$2.56	$3.16	$3.37	$4.13	$5.12	$6.63
Percent of Income[c]	0.016	0.090	0.035	0.026	0.019	0.017	0.015	0.011
Total bGH Contribution								
Total (Dollars)	$9.03	$4.89	$6.80	$8.24	$8.26	$9.41	$11.56	$13.23
Percent of Income[c]	0.037	0.234	0.093	0.067	0.047	0.039	0.034	0.022
Corrected for Family Size (Dollars)		$7.48	$8.42	$8.93	$8.95	$9.06	$10.02	$10.75
Corrected for Marginal Utility and Size (Dollars)		$9.90	$10.78	$10.96	$10.36	$10.04	$9.95	$9.43

Source: See text.
[a] Components do not sum to total because of sample omissions.
[b] Weekly expenditures multiplied by 52.
[c] Percent of income before taxes.
[d] Consumption multiplied by farm share of .49 in 1985.
[e] Consumption multiplied by farm share of .36 in 1985.

small at the family level is not small in aggregate: as noted earlier bGH raises national income by approximately $1 billion per year when its full effects are considered.[5]

Data at the top of Table 1 provide clues to characteristics of low income families. Many of lowest income families are one-person households. The relatively high age of the reference person in low income families implies a considerable number of aged population. Low income families also include a number of households with children -- as apparent from the ratio of earners to children under 18 (Table 1). Whether the low income families are predominately aged persons or are young families with a disproportionate number of children, they can well benefit from lower dairy product prices made possible by bGH.[6]

Some might contend that income transfers such as free school lunches, food stamp programs, and housing assistance are a better way than is bGH to serve equity objectives. A unique advantage of bGH is that it strongly serves both *efficiency* and *equity*. It is not possible to rely solely on transfer payments to assist the poor because there is "no free lunch"; someone must pay. When there is no "pie," the issue of how to divide it is academic. The ability to fund social assistance programs such as food stamps is made possible only because of economic efficiency gains from technologies such as bGH.

Two adjustments in Table 1 largely remove differences in bGH benefits among families. An adjustment to the average family size for the nation raises benefits for the lowest income families from $4.89 to $7.41. This contrasts with family-size-adjusted benefits from bGH for high income families of $10.75. An adjustment for marginal utility of income and the family-size brings bGH benefits per lowest income family up to $9.90 and for the highest income family down to $9.43 in Table 1 (see Tweeten and

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[5] Higher income families receive a larger absolute benefit than lower income families from bGH. The income gains of $4.89 for families earning less than $5,000 per year in 1985 appear to be small. Technologies such as bGH would have to occur ten-fold to improve the lot of families with incomes under $5,000 per year by just 2 percent annually. It is important to note that bGH is simply one of a substantial number of simultaneously occurring improvements in productivity. Withholding it does not necessarily require withholding any other technology that improves productivity, but one must ask why hold back bGH with such favorable economic equity and efficiency payoffs and not hold back other technologies?

[6] Benefits of bGH were also calculated for 1982-83 and 1984 based on Bureau of Labor Statistics data for those years. Results were surprisingly similar to those for 1985, indicating that benefits are not highly sensitive to the year chosen for analysis.

Mlay for utility function estimates). Thus low income families receive more absolute, utility-adjusted benefits than high income families from bGH.[7]

Regional Impact

According to estimates by Fallert *et al.*, the Lake States and Northeast regions generally would have the highest rates of dairy cow and farm exits with introduction of bGH. Because of high production per cow and low production cost, the Pacific region would have a low rate of exit. Rising costs of irrigation water could accelerate exits from the Pacific region, however. The Corn Belt, Southern Plains, and Appalachian regions would have moderate rates of exit. The Southeast, because it is favored by federal milk order price differentials and growing milk consumption, would have the lowest rate of exit.

Recent results from Hallberg and Fallert give a different picture. They found that with bGH the share of milk produced in the upper Midwest and Northeast would increase while that of the Pacific, Northwest, and Southern Plains regions would decrease.

Weersink and Tauer, based on a 16 percent increase in dairy productivity over trend, projected from 1988 to 2000 that the nation's share of milk production would increase 17 percent in the Pacific region, 8 percent in the Lake States, 5 percent in the Northeast, and would decline in other regions as a whole. Some evidence indicates bGH would strengthen comparative advantage in regions with the best management (Pacific), temperate-climate (not the South), and lowest current cow productivity (Corn Belt and Lake States). As with the above empirical studies, these predictions give mixed signals. In view of the conflicting findings, the conclusion is that differing regional impacts of bGH are too close to predict and will likely be of modest size.

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[7]While bGH research and development funding was presumed to be by private firms which in turn recover their costs through charges for the hormone paid by farmers, it is recognized that the public sector paid for some of the research. This is not accounted for in Table 1. The net effect of adjusting data in Table 1 for public outlays to develop bGII cannot be determined but is likely to leave the results largely unchanged.

Minnesota and Wisconsin have legislated barriers to bGH motivated presumably by a desire to preserve family farms. That strategy could backfire if other states adopt. Hallberg and Fallert (p. 15) found that the market share of milk production in the Upper Midwest would fall markedly if bGH is rejected but would rise if bGH is adopted.

Farm Size Impact

Given the inelastic demand for dairy products, a 15 percent increase in milk per cow eventually would reduce the number of cows by nearly the same proportion. If bGH were scale neutral in its primary and secondary incidence, all sizes of farms would share equally in the 15 percent decline.

In primary incidence, bGH is nearly scale-neutral. It is easily divisible and hence entails no sizable cost savings by spreading a high fixed cost of a lumpy input over more units. It is rather simple to apply by hypodermic injection about once per month. It potentially can raise output per cow as much on a small farm as on a large farm. Perhaps that is one reason why Kinnucan *et al.* found no association between farm size and intended intensity of use as measured by the proportion of their dairy herds on which farmers planned to apply bGH, based on a survey of Southeast region farmers. Fallert and Blayney (p. 5) asserted that "On balance, it appears that bST is size neutral."

Secondary economies of size arise because, even with primary scale-neutrality noted above, the more innovative, able managers who adopt bGH are on larger farms. Large farms have lower information acquisition costs per unit, can handle risk by, for example, experimenting on a reliable subsample of cows, and have a higher level of human capital to facilitate processing of information. These reasons help to explain why Kinnucan *et al.* (p. 10) found that a higher proportion of large than of small farmers intended to adopt bGH.

Kalter *et al.* reported a fairly modest impact of herd size on adoption rate but the Office of Technology Assessment (OTA, 1986, p. 131) assumed adoption rates of 10 to 20 percent for farms with less than $20,000 of sales and 80 to 90 percent for farms with over $500,000 of sales. I do not anticipate that adoption rates will differ this much among farm sizes but secondary scale effects clearly will favor adoption by larger farms. For that reason a 15 percent decrease in cow numbers may result in a 20 percent reduction in dairy farm numbers.

The difficulty of farming adjustments will depend on the time path of adoption. The OTA's projection of a 25.6 percent increase in milk production in three years implies rapid adoption. Fallert *et al.* assumed a 10-12 percent adoption rate in year 1, and rising to 45-70 percent by year 7, with the higher rates associated with higher prices.

Buttel doubted adoption rates would be so rapid, noting that hybrid corn took 10 years to achieve 95 percent adoption. Only 70 percent of the U.S. dairy herd was artificially inseminated four decades after commercial introduction of that superior management practice (Kloppenberg). If 10 percent of farmers adopted bGH each year and each adopter increased milk output 18 percent, production would increase 1.8 percent per year due to bGH and the 15 percent expansion of output would be achieved in 8 years (80 percent adoption).

Could farmers absorb this rate of expansion without economic trauma? Figure 2 shows that the rate of increase in milk output per cow was linear from 1950 to 1990 (see footnote a, Figure 2 for equation and adjusted R^2 of .995). A linear expansion implies a declining geometric rate of growth. Trend rates of increase taken from the well-fitting equation for Figure 2 were as follows:

Year	Annual Growth in Milk Output/Cow (%)
1950	5.0
1960	3.3
1970	2.5
1980	2.0
1990	1.7
1995 (projected)	1.5.

Adding anticipated growth from bGH of 1.8 percent per year to the 1990 trend rate brings the total rate to 3.5 percent per year. This rate is well below the trend rate in 1950 and by 1995 would be equal to the 1960 rate. Hence introduction of bGH would fall well short of restoring the trend rates of the 1950s. The number of farmers exiting agriculture in the 1990s will be few compared to the number who left in the 1950s or 1960s. The expected decline in dairy farms from bGH is only .5 percent of the 3.5 million dairy farm decline from 1950 to 1990. Because leavers will be a small fraction indeed of the total U.S. labor force, they will more readily find nonfarm job opportunities than did displaced farmers in early decades.

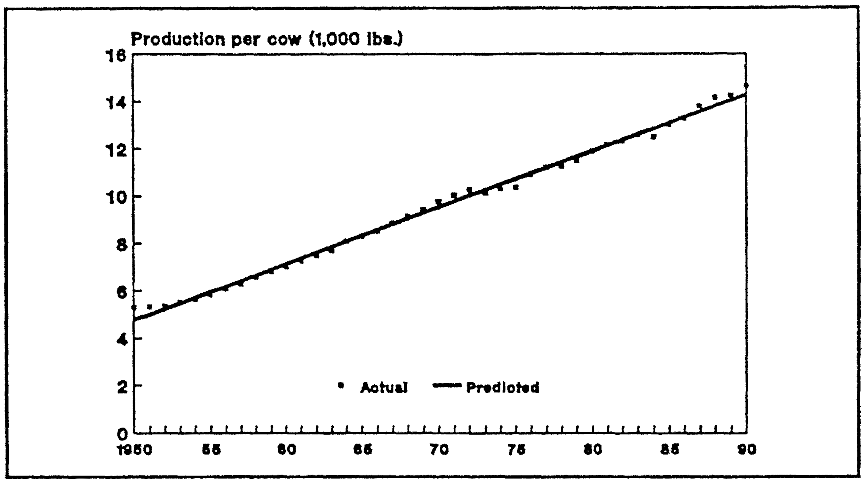

Figure 2. Actual and Predicted Milk Production per Cow, U.S., 1950 to 1990.
[a] Regression is Y = -7096.65 + 237.58T Adj. R^2 = .995
(182.59) (2.57)
where Y is pounds of milk per cow, T is last two digits of current year.
Standard errors in parenthesis.

Family Farm Structure

According to Comstock (p. 320), "Part of the problem with bGH is that it discriminates against small- and medium-size farmers, the same farmers who helped to pay for research on it." Private firms funded and conducted most of the bGH research and development. The public invested mainly in biomedical research.

Of the small amount of public funds used to fund bGH research, what portion did small- and medium-size farmers contribute? Farmers receive much more income transfers than they pay in taxes for research. In fact, income tax receipts would increase by billions of dollars if the tax were removed from farmers (Sisson)! The farming industry's net tax writeoff has been smaller since tax reform in 1986, but small- and medium-size farmers probably will continue to be a major net draw rather than contributors to federal revenue. Farmers, of course, pay state sales and excise taxes contributing to research funding. But even if producers contributed proportionately out of their income to fund research, mid- and small-size farms with under $250,000 of annual sales which account for only 1 percent of national income also would contribute 1 percent of taxes. Because nonfarmers finance nearly the whole of public agricultural research, such nonfarmers as consumers deserve to receive benefits.

Comstock (pp. 322, 323) speaks of an unwritten social contract between agricultural research institutions and the farmers who support them. "The farmers pay taxes that go for salaries and equipment; the institutions are supposed to deliver seeds, machines, and techniques that will make farming more productive and profitable for all kinds of farmers." Later (p. 325), he asserts that "The land-grant university system has not taken care to make sure its research is equally beneficial to all sizes of farms." The clear implication is that it *should* be equally beneficial to all sizes of farms. Because markets cause farm and food prices to fall (or to rise more slowly) as productivity rises, gains from public research eventually go to consumers and not to producers.

Should research benefits go to producers? Adequate-size, reasonably well-managed farms have earned returns comparable to what their resources would earn elsewhere (see Tweeten, 1989, Ch. 4). It is difficult to make a case that farmers should be rewarded better for their resources than nonfarmers. Farmers as well as nonfarmers gain from technology as consumers. Farmers who are early adopters of successful technologies also gain.

The estimated eventual reduction of dairy farms by 20 percent with adoption of bGH does not mean a like reduction in number of farms, farm families, or farm labor. Many former dairy farmers would become cash grain, beef, hog, or other types of farmers. Labor utilization would expand with greater milk production on many farms using bGH. Nevertheless, some dairy farm operators and workers would exit farming. At issue is whether they would be worse off.

Growing number of studies indicate that most of those who left farming were not made worse off. Those who left as youth or retirees had relatively few adjustment problems. As for those who made mid-career adjustments, a recent study in Oklahoma indicates former farmers are better off on subjective grounds (they say they are better off) and on objective grounds (they have better income, housing, access to services such as education, etc.). When former farmers were asked to "Compare your life now with your life while farming," replies were as follows (Perry, Schreiner, and Tweeten, p. 12):

	(Percent)
Much better off	27
Somewhat better off	24
About the same	32
Somewhat worse off	6
Much worse off	11
	100.

Fully 51 percent said they were much or somewhat better off compared to only 17 percent who said they are somewhat or much worse off -- a 3:1 ratio. These results support several studies in the 1960s and early 1970s summarized by Tweeten and Brinkman (see pp. 88-92).

This is not to say that farm families making mid-career adjustments could not have been better prepared. Public programs of general education, counseling, job information, vocational-technical training, and other mobility assistance could reduce problems of adjusting to new employment. These programs could be financed from bGH benefits to society.

Bovine Welfare

Some (see Comstock) have argued that bGH will be cruel to cows because (1) daily injections cause pain, (2) the hormone will encourage confinement systems, (3) cows will "burn out" from stress on their biological system over several lactations, and (4) farmers will overdose bGH to produce more milk. These charges lack merit.

The more than 11,000 cows studied in the United States alone since 1985 provide insights into the impact of bGH over several lactations and different management practices. Major findings include:

1. A successful prolonged-release system of bGH administration has increased milk production in treated cows by 20 percent. Injections are needed only once each 21 days rather than daily (CAST, p. 3).

2. Most dairy cattle today do not get their forage from pastures. Most are raised in confinement but milking parlors, free stalls, and open housing have replaced stantions on progressive farms. That situation is unlikely to be changed much by bGH.

3. Cows administered bGH for four lactations gave similar milk responses each lactation (CAST, p. 3). No evidence of detrimental effects on cows was found through four lactations. In general, high producing cows have more disease problems than low producing cows. Among high producing cows the incidence of mastitis was no greater for cows receiving bGH. OTA (1991, p. 14) reports that bGH "does not produce adverse health effects on cows."

4. Farmers are unlikely to overdose bGH -- to do so would reduce profits. Successful commercial farm operators are well aware that poor care of cows will drive them out of business. Because poor managers and poor care of cows often go together, it follows that a reduction in numbers of inefficient operators because of bGH could leave milk production in the hands of producers attaining higher levels of animal welfare than do exiting producers.

Product Safety

Milk from cows administered bGH is safe for human consumption (OTA, 1991, p. 14). Bovine somatotropin or bGH, produced by the cow's pituitary gland, is found in all milk. Milk from bGH-treated cows contains normal concentrations of bGH. The hormone is inactive in humans and is digested like any other protein. In addition, pasteurization deactivates 70 to 90 percent of bGH in milk (CAST, p. 3). Flavor, cholesterol concentration, and somatic cell counts are normal in milk from bGH-treated cows.

The Food and Drug Administration (FDA) determined by 1985 that milk produced by bGH-treated cows is safe. On December 7, 1990, a panel of medical doctors and scientists convened by the

National Institutes of Health confirmed a December 1989 statement by the deputy director of the FDA: "BST [bGH] is one of the safest products we've ever looked at" (Those terrifying cows, p. A12).

Yet in April 1990, the Governor of Wisconsin signed legislation to bar use of bGH until June 1991; later this was extended another year. Minnesota enacted a similar ban. Several ice cream stores and five major grocery chains announced they will not market ice cream and milk produced by bGH-treated cows. A major reason is a campaign of distortion and vilification of recombinant bGH mounted by social activists.

Other Criteria

Comstock (p. 330) asks "At the environmental level, what is the cost in soils and water when fewer farmers, increasingly dependent on pesticides and herbicides, increase their holdings?" The implicit assumption is that small farms do less environmental damage than the remaining larger farms. The weight of empirical evidence contradicts that assumption. Small farms take poorer care of their land and use more nonrenewable energy fuels and agricultural chemicals per unit of output than do larger farms (Tweeten, Forthcoming). Society may have sound reasons to preserve small farms but protection of the environment and natural resources is not one of them. Improved productivity has freed millions of acres from crops for more environmentally benign use such as permanent pasture, recreation, forests, and wetlands.

Conclusions

Comstock (p. 333), drawing on Leopold states that "We should oppose only those technologies that unfairly advantage one social group over another, that displace workers at unacceptably high costs, or that threaten the stability, beauty, or integrity of the plant or animal kingdom." Later Comstock (p. 333) writes "We do not want those [technologies] that are destabilizing, inhumane, or ugly..."

Taken seriously, such statements could stop any new technology! Concepts such as "unfairly advantage," "unacceptably high costs," and "integrity of the plant or animal kingdom" are vague and subjective. It is altogether proper that technologies be scrutinized for safety and other impacts before release. But appraisal must be on more objective terms than "ugly," "beauty," and "integrity."

According to my analysis, application of bGH would:

1. Reduce the real cost of milk production and milk prices, especially beneficial to low income consumers. Data indicate that bGH is an economically efficient technology whose benefits are far more equitably distributed than is all food or all goods and services.

2. Reduce claims on natural resources through greater productivity of conventional resources. Thus bGH promotes an environmentally sound food and agriculture system.

3. Keep the U.S. dairy industry competitive with industries elsewhere and with products such as beverages and desserts which compete with dairy products. This will be especially needful and beneficial if the Uruguay Round of trade negotiations under the General Agreement on Tariffs and Trade result in liberalized trade, making the dairy industry a competitive global market.

4. Free labor and other resources in agriculture for use in other activities such as education, health, or recreation where they are valued more highly by society. Introduction of bGH would encourage less efficient dairy farms to become more efficient or find opportunities in other parts of the farm or nonfarm economy. The structural impact on farm sizes and numbers would be very small compared to the milking machine or tractor.

A nation's economic vitality depends on its capacity for renewal. In a dynamic, growing economy, profitable and productive new inputs, practices, and technologies continually replace the unprofitable and the unproductive. Individuals and firms that are innovative, imaginative, or lucky drive out those which are unimaginative, unmotivated, or unlucky. Nations (East Europe provides excellent recent examples) which would avoid this process stagnate, falling ever further behind in the competitive process that has lifted mankind from the cave to lives of better nutrition, health, self-realization, and self-fulfillment.

The farming industry's capacity for self-renewal is apparent from farm entry and exit data. Comstock (p. 325) creates an image of doom when he notes that "In 1986, 6 percent of all farmers went out of business; one farm every four minutes. In 1985, the figure was 5 percent." He did not note that these are gross exits. Half of these exits were aged farmers who retired or died. In the farm financial crisis years 1982 to 1987, the annual entrance of new farm operators averaged nearly 4 percent of all farm operators. New farm entrants outnumbered mid-career exits nearly 2:1. The overall farming population dropped only 1.4 percent annually on average in those difficult years of 1982 to 1987 (Bureau of the Census).

A society pressed to pay off debts or to fund education, infrastructure, and a host of other high priority needs can ill afford to turn down a technology that is safe and equitable while adding nearly $1 billion per year to national income. Foregoing that benefit may be regarded as the cost of preserving family farms.

Based on the assumption that the adjustment to bGH would occur over 8 years, an estimated 2,247 farms or .1 percent of all U.S. farms would be lost each year to bGH.[8] The value of all future benefits discounted at 5 percent would be $8.9 billion or $500,000 per displaced farm. Thus, by adopting bGH, consumers could pay each displaced farmer $500,000 and be no worse off.

Failure to utilize bGH imposes an annual *implicit* tax of $9 per average family. If public policy imposed an *explicit* tax of $9 per year on every family consuming dairy products, the howl of protest

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[8] Assuming a 5 percent discount rate and that bGH has the same 16-year length of life as the average of other agricultural technologies (see Braha and Tweeten), the discounted present value of bGH is $8,949 million from annual benefits of $826 million. Assuming bGH causes exit of 20 percent of the 138,311 dairy farms (Bureau of the Census) and that 35 percent of these shift to cash grain or other types of farms (see Perry, Schreiner, and Tweeten), then 17,980 dairy farms or 1 percent of all U.S. farms would be lost to bGH. Decoupled payments or adjustment assistance of $497,712 ($8,949 million / 17,980 farms) could be made per farm lost to compensate for damages.

from (properly) outraged social activists would be deafening. But to consumers, the impact of an implicit or explicit tax is the same.

To previous knowledge that bGH is safe and economically efficient, this study adds that bGH is about as equitable in distributing benefits to low-income consumers and about as scale-neutral in preserving farms as technology gets. If the nation does not pursue safe and efficient new technologies such as bGH, it eventually will lack the resources to support environmental and other worthy social goals.

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